C H A P T E R 1 0

Graphics Adapters and Video

INDUSTRY EARLY REVIEW DRAFT V.0.3 — 7/21/99 9:16 PM–

NOTE to REVIEWERS: This is a very early draft version, and no effort has been made to reconcile changes in cross references to other chapters in the guide.

Please look for comments such as this in the draft, which encourage your feedback on specific issues.

In this draft, former PC 99 Graphics and Video chapters are combined into a single chapter. Please comment on the utility of this organization.

Please submit comments using the form on http://www.pcdesguide.org or by sending e-mail to comments@pcdesguide.org.

IMPORTANT: The requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 "Millennium" or later or Windows 2000 Professional or later operating systems. These design guidelines are not the basic system requirements for running any version of Windows operating systems.

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This chapter presents the requirements for the graphics subsystem, video and broadcast components, and related adapters.

The key design goal is to ensure that graphics and video hardware behave consistently across a wide range of applications, based on the need of the system to provide fast, high-quality rendering.

For exceptions and guidelines for the internal graphics subsystem on mobile PCs, see “Mobile PC Graphics Design” at the end of this chapter.

Graphics Guidelines

This subsection covers basic graphics guidelines, including resolution and color depth plus 2-D and 3-D acceleration.

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.5.

Baseline Graphics Features

This section defines the basic guidelines for graphics adapters and the graphics subsystem.

[New.1] Desktop system meets basic PC 2001 graphics requirements

The following graphics capabilities are required:

?? 1024x768 x ~~24~~32 bpp @ 85 Hz refresh frequency

?? 2-D acceleration

?? 3-D acceleration

?? Multi-monitor support

?? Digital Visual Interface (DVI) or VGA

14.1 Primary graphics adapter uses ~~PCI,~~ AGP 2X or another high-speed connection

REVIEWERS: PCI devices will only be allowed for secondary display.

OEMs are encouraged to use an Accelerated Graphics Port (AGP) 4X attachment with optional sideband addressing and double-clocked data transfer mode, as defined in *Accelerated Graphics Port Interface Specification, Revision ~~1.0~~2.0* or later, plus PC 2001 requirements defined in "AGP Requirements" later in this chapter.

Notes:

?? Integrated chipset designs that incorporate graphics features must meet or exceed the levels of performance specified for AGP 2X in the AGP 2.0 specification.

?? Other buses may be used for secondary graphics adapters.~~In all cases, PCI adapters can be used as secondary graphics adapters.~~

REVIEWERS: Please provide input on specific requirements for integrated parts.

~~**Note:** It is anticipated that AGP, or an integrated graphics subsystem that meets or exceeds AGP performance levels, will be required for all system types in the next version of this design guide.~~

14.2 Desktop system provides hardware-accelerated 3-D graphics

Many of the level of quality features being implemented in GDI+ as well as enhanced user interface features planned for PC 2001 systems will rely on Microsoft DirectDraw and Direct3D being fully implemented in the graphics subsystem. Accordingly, all systems must include DirectX acceleration for 2D and 3D.

The graphics adapter requirements on PC 2001 systems that implement 3-D acceleration are defined in "Hardware Acceleration for 3-D Graphics" later in this chapter.

For ~~most~~all systems, 3-D acceleration is based on Direct3D capabilities provided in the operating system.

Systems designed as Windows graphics workstations must include a 3-D accelerator that supports Direct3D and may optionally support OpenGL as well. All hardware accelerated features of the OpenGL accelerator must be accelerated under Direct3D except for those features not supported by the current released version of Direct3D. OpenGL support can be implemented under Windows as a Mini Client Driver (MCD) or Installable Client Driver (ICD). OpenGL driver support for Windows 98 can only be implemented as an ICD.

Implementation details for OpenGL and DirectX are contained in the Windows 98 DDK and Windows 2000 DDK.

14.3 System uses WC with higher-performance processors

REVIEWERS: Please provide input for hardware requirements for this item.

Write combining (WC) of successive stores to the frame buffer is a requirement for systems with processors that support write combining.

[New. 2] If implemented, digital monitor interface complies with Digital Visual Interface standard

If a digital monitor interface is provided, it must be based on the DVI specification. In the future, there will be significant display dependency on digital interfaces. It is anticipated that a digital interface will be required It is recommended that a digital monitors interface be implemented rather than analog.

14.4 Primary graphics adapter works normally with default VGA mode driver

The default video graphics array (VGA) driver is required for installing the operating system. The primary adapter must support 4-bit planar VGA mode as described in the Windows 98 DDK and the Windows 2000 DDK. The adapter must also support VGA Text Mode 3. Because digital monitors usually do not support text modes, the adapter needs to emulate Text Mode 3 for such connections.

14.5 Adapter and driver support multiple adapters and multiple monitors

System expansion buses that allow graphics adapters such as PCI and AGP can support the simultaneous use of more than one graphics adapter in the system. Each graphics adapter can support one or more attached monitors, but this is not a requirement. Multiple-monitor support can be implemented using add-on PCI graphics adapters.

The device drivers for each graphics adapter must provide the required support to allow the presence of multiple adapters and multiple monitors. The hardware and BIOS support consist of Plug and Play-related configuration and resource requirements that ensure automatic support for use of more than one graphics adapter and for simultaneous display on two or more monitors. For details, see "Multiple-Adapter and Multiple-Monitor Support" later in this chapter.

Mobile PC Note

For mobile PCs, multiple adapter support is not required ~~unless the mobile system supports a full docking station~~. ~~For information, see requirement 6.20, "Mobile system meets Mobile PC 99 requirements for supporting multiple adapters and multiple monitors."~~

14.6 [DELETE] Adapter supports television output if system does not include large-screen monitor

14.7 [Redundant] Adapter meets PC 2001 general device requirements

REVIEWERS: This is a basic requirement for all devices, so it is no longer repeated here

14.8 Desktop screen resolution and local memory capacity meet PC 2001 minimum requirements

~~The adapter must support all required resolutions, including:~~

~~640 × 480 × [8, 15 or 16, 24 or 32] bpp~~
~~800 × 600 × [8, 15 or 16, 24 or 32] bpp~~
~~1024 × 768 × [8, 15 or 16, 24 or 32] bpp~~

~~The following resolutions are recommended:~~

~~1280 × 1024 × [8, 15 or 16, 24 or 32] bpp~~

~~1600 x 1280 x [8, 15 or 16, 24 or 32]bpp~~

~~It is acceptable to implement either 15-bit or 16-bit color mode, and it is also acceptable to implement either 24-bit or 32-bit color modeThe 32-bit mode is preferred required rather than the 24 bit mode because it provides more spare8 bits for alpha blending capability.~~

All PC 2001 systems, ~~except for the Mobile PC built-in graphic subsystem,~~ must support a minimum resolution of 1024x768, 32 bpp, double buffered in 2D mode and ~~provide for rendering buffers of up to~~ 1024 x 768 × 16-bit bpp (double-buffered), 16-bit Z-buffering in 3D mode. It is anticipated that 32bpp and 32- bit Z are anticipated towill be required for 3D in future design guides.

~~, and a X.Y MB texture cache. This requires an effective memory footprint of approximately 3 MB. For AGP-enabled systems, which store and execute textures directly from AGP system memory, there is no texture cache requirement.~~

~~Designs should provide sufficient 3-D texture access to meet the 3-D performance recommendations defined in requirement 14.34, "Hardware meets PC 2001 3-D accelerator performance requirements."~~

~~Texture compression can provide additional effective texture memory; it also increases the effective memory bandwidth that is available.~~

Mobile PC Note

Mobile systems must support the capabilities listed above that meet the capabilities for the attached LCD panel and equal to or lower than that resolution for any attached external monitor. Mobile PCs that implement a single chip multi-head configuration must meet the above resolution (not color depth) requirements for any attached monitor independent of the LCD panel's capabilities.

14.9 Adapter meets industry ~~VESA~~ specifications for External Display Interface(s)~~ergonomic timing rates~~

~~Recommended:~~ Display adapters often implement more than one display interface (for example, VGA and DVI, VGA and NTSC, Dual VGA, DVI and NTSC, .and so on). Each interface that is implemented must comply with the appropriate industry specification (or specifications) for that interface as cited below.

?? Analog VGA: Output must support a minimum of 85 Hz , (non- interlaced at the specified minimum resolution (1024 × 768)~~, non-interlaced.~~.

~~For mobile PCs, see "Mobile PC Graphics Design" at the end of this chapter.~~

The graphics adapter must support, at a minimum, the 85 Hz ergonomic timings for all resolutions supported by the monitor up to 1024 × 768. As documented in the current version of *VESA and Industry Standards and Guidelines for Computer Display Monitor Timing*, higher timings and resolutions are preferable under standards published by Video Electronics Standards Association (VESA). Additionally, in order to provide optimal support for video playback in either NTSC or Pal the display adapter must support the appropriate NTSC (59.94 Hz) or Pal (50 Hz) refresh rate to assure smooth frame delivery in TV based video content applications.

?? Digital Visual Interface -: must implement the timings as specified in the current revision of the Digital Visual Interface Specification provided by the Digital Display Working Group.

~~For TV-enabled systems, in addition to the standard VESA timings, it is also necessary to support the 59.94-Hz variants of the 60-Hz timings. This is important for smooth frame delivery in TV video applications.~~

Notes:

?? Single-chip multi-head devices that support independent displays must be able to meet this requirement on both displays simultaneously and independently—for example, 85 Hz on the PC monitor while displaying NTSC TV out or DVI.

~~For flat panel displays for desktop or mobile use, it is not necessary to implement refresh rates higher than 60 Hz. For additional exceptions and requirements for mobile PC systems, see "Mobile PC Graphics Requirements" in Chapter 6, "Mobile PC 99."~~

?? Regarding interlaced display modes: When the user selects 1024 × 768 resolution, the graphics adapter must default to a non-interlaced refresh rate. A graphics adapter can default to 1024 × 768 interlaced mode in either of the following situations:

The attached monitor is not DDC-compatible and the user has not selected a monitor type in the display control panel.

The monitor does not support 1024 × 768 non-interlaced mode, as determined from the Extended Display Identification Data (EDID) or monitor registry settings.

14.10 All supported color depths are enumerated

The driver must enumerate all modes supported so that applications can choose their preferred color depth. The driver must comply with the following guidelines for enumeration:

?? For 16 bpp, either the 5:5:5, 5:6:5, or both modes must be supported.

?? If only the 5:5:5 mode is supported, the driver must also enumerate this as 16-bpp mode. This is required because some applications only look for 16-bpp support and will run in 8-bit mode if they fail to find a 16-bit mode.

?? If both 5:5:5 and 5:6:5 modes are supported, both modes must be enumerated.

For each color depth supported, color ordering must be implemented as shown in the following list. Color ordering is shown in the following list from the most- significant bit (MSB) to the least- significant bit (LSB.)

Mode	Color ordering
15 bpp	1 undefined, 5 red, 5 green, 5 blue (URRR RRGG GGGB BBBB)
16 bpp	5 red, 6 green, 5 blue (RRR RRGGG GGGB BBBB)
~~24 bpp~~	~~8 red, 8 green, 8 blue (RRRR RRRR GGGG GGGG BBBB BBBB)~~
32 bpp	8 alpha, 8 red, 8 green, 8 blue (AAAA AAAA RRRR RRRR GGGG GGGG BBBB BBBB)

14.11 Graphics operations use relocatable registers only

VGA registers must not be used to perform graphics operations such as bit blting, palette setting, and pointer movement. The registers used for these graphics operations can be either I/O locations or memory-mapped locations, but must be relocatable. Normal system operation should never require use of base VGA registers, except for system startup and mode setting.

DirectDraw and Direct3D functionality must be independent of VGA. This means that graphics require VGA only for initialization.

14.12 Adapter supports adjustable gamma correction ~~Adapter supports downloadable RAMDAC entries for integrated color management~~

Integrated Color Management (ICM) uses this capability to perform Gamma correction for the attached monitor and to allow game applications to switch palettes. This capability also supports transition effects in applications. To provide support for ICM the graphics adapter gamma ~~curves~~ must be programmatically adjustable. It is ~~recommended~~ required that ~~for graphics adapters that support~~

32bit or higher displays, downloadable RAM digital-to-analog converter (RAMDAC) entries should be included to perform gamma correction in hardware at 24 bpp.

This capability must be supported without requiring the use of any VGA resources as the related requirement to use VGA only for system initialization defined in requirement 14.11, "Graphics operations use relocatable registers only."Integrated color management (ICM) uses this capability to ensure that gamma is correct in the monitor and to allow game applications to switch palettes. This capability also supports transition effects in Internet Explorer 5.0 and other applications.

14.13 Adapter for external display supports DDC Plug and Play monitor detection

This requirement is based on the *Display Data Channel Standard, Version 3.0* (DDC), which defines the communication channel between the display and host system. The software can use this information to properly manage output to the various displays and to prevent the disabling of television output if no monitor is attached. Devices capable of multi-head display must support this feature for all attached monitors.

Systems are not presently required to support plug and play detection of the internal display if it is non-detachable. However, in order to provide the best possible user experience, it is highly desirable that this be supported going forward. Because a wide range of LCD and other flat panel display types may be implemented, it is necessary that the characteristics of the display panel be available to the system in order to optimize the quality of the display output. Implementation of DDC detection for internal displays will be required when an appropriate standard is developed.

Mobile systems are not required to support DDC monitor detection of the display if the display is permanently attached and connected using an internal interface. However, such systems must support DDC for the external monitor interface port.

14.14 [moved] Hardware supports video overlay surface with scaling

14.15 [moved] Hardware supports VGA destination color keying for video rectangle

14.16 [moved] Hardware supports alpha blending of graphics and video

14.17 [moved] Video port meets specifications if present on graphics adapter

REVIEWERS: These items moved to the "Graphics Subsystem Support for Video" section later in this chapter.

14.18 [DELETE] Hardware supports MPEG-2 motion compensation acceleration

Recommendations are not included in PC 2001.

14.19 [DELETE] Hardware supports scanning at the same frequency as the incoming video

Recommendations are not included in PC 2001.

Multiple-Adapter and Multiple-Monitor Support

This section defines the requirements for ensuring system support for multiple adapters and multiple monitors. This support ensures that if the user adds a second adapter, resources will automatically be available and the operating system can automatically manage multiple display adapters.

The actual implementation a user might employ could be one of the following:

?? Multiple adapters added to the PC system

?? A single adapter with a single controller supporting two monitors (single- chip multi-head)

?? A single adapter with multiple controllers supporting multiple monitors (multi-head)

?? Any combination of these scenarios

Multi-monitor support requires multiple-adapter/ multiple-monitor compatibility in the BIOS, plus the graphics adapter and its driver. This support also requires allowing any secondary graphics adapters to be enabled in VGA mode, thus requiring that VGA for the previous adapter be temporarily disabled.

With this support, a single adapter that supports multiple monitors can display independent screen images. The operating system support therefore also assumes that the different displays might have differing X, Y coordinates, resolutions, color depths, refresh rates, and display capabilities.

For technical details about implementing driver support for multiple adapters and multiple monitors, see the Windows 98 DDK and the Windows 2000 DDK.

14.20 Extended resources can be dynamically relocated after system boot

To ensure Plug and Play for multiple-adapter/multiple-monitor capabilities, all non-VGA standard display resources, also known as extended resources, such as register sets and so on, must be capable of being dynamically relocated after system boot (after POST).

This is an extension of requirement 14.11, “Graphics operations use relocatable registers only,” plus the general Plug and Play requirements.

14.21 VGA resources can be disabled by software

A means must be provided to allow a driver to disable its adapter from decoding standard VGA addresses to ensure that the adapter is independent of all other graphics adapters in the system. The adapter must remain fully functional without the VGA addresses. See also requirement 14.11, “Graphics operations use relocatable registers only.”

Hardware Acceleration for 2-D Graphics

This section summarizes guidelines related to 2-D ~~DirectDraw~~ graphics features, which can be implemented as hardware acceleration features.

All PC 2001 systems require hardware acceleration for 2-D graphics. Robust DirectDraw support is also required to allow 3-D hardware accelerators to take full advantage of the DirectX architecture.

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.5.

14.22 Frame buffer can be accessed directly by applications

The visible frame buffers must be accessible. It must be possible for applications to perform direct frame buffer accesses at any time, even while asynchronous accelerator operations are being executed. Without this capability, drivers cannot support DirectDraw or Direct3D on Windows 2000, and operations on Windows 2000 will not be fully robust.

Some hardware keeps the information in its frame buffers in a format that does not correspond to the linear format standard in DirectDraw, such as tiling the pixels to exploit the 2-D coherence of image data. If this is the case, the hardware must perform translations so that DirectDraw surfaces being accessed directly appear linear. The hardware performing this translation might be a limited resource, but it must be able to perform translations on at least seven DirectDraw surfaces simultaneously. Support for eight or more surfaces is recommended.

14.23 Adapter and driver support linear-mapped, low-resolution modes

All graphics adapters currently support linear-mapped low-resolution modes, with minimal driver work needed to support this requirement. Decreasing the size of the frame buffer decreases the average polygon size and increases the frame rate for a given scene. These additional modes provide support software rendering for games and software Direct3D.

If low-resolution support is implemented in the hardware, the following low-resolution modes are required:

320 × 200 × 16 bpp	320 × 240 × 16 bpp	640 × 400 × 16 bpp
320 × 200 × 8 bpp	320 × 240 × 8 bpp	640 × 400 × 8 bpp

The following low-resolution modes are recommended:

400 × 300 × 16 bpp	512 × 384 × 16 bpp
400 × 300 × 8 bpp	512 × 384 × 8 bpp

Note: In Windows 98, low-resolution capabilities must not be defined in the registry so that they do not appear in the display control panel. In Windows 2000, the control panel automatically filters out these modes.

14.24 Hardware supports transparent blter

There is no restriction on source size. A transparent blter can perform a blt with a source key transparent color. This assumes that the blter is asynchronous with the host processor.

14.25 Hardware provides support to prevent tearing

This must be performed in synchronization with the VBI.

The hardware must support a mechanism for preventing visible artifacts such as “tearing.” The mechanism for doing this is at the discretion of the hardware designer, but it should support tear-free capabilities for both full-screen and non-occluded windowed applications. Only one of two simultaneous display of the same image on two displays (for example, internal mobile panel and external VGA monitor attached) needs to meet this requirement.

Except when explicitly requested to do otherwise by an application (via DirectDraw), blts must be performed in synchronization with the vertical scan line to avoid tearing. The ability to read the current scan line supports blting or writing to the screen without tearing. In some contexts, such as video playback, this support eliminates the need for the secondary overlay buffer. Other exceptions to this requirement may be allowed and will be documented in the Windows 2000 DDK.

For information about the upper limits of resolution to be supported, see requirement 14.8, “Screen resolution and local memory capacity meet PC 2001 minimum requirements.”

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.5.

14.26 Hardware supports programmable blter stride

This is required as part of the support for textures. A programmable blter stride ensures that Windows can use linear memory. A fixed stride forces Windows to use rectangular memory management, with all the related inefficiencies. It must be possible to specify different strides for the source and destination on blts.

Hardware Acceleration for 3-D Graphics

This section summarizes guidelines related to Microsoft Direct3D technologies that can be implemented as hardware acceleration features. Supporting the items in this section result~~s~~ in improved performance and improved memory use. ~~Support for 3-D graphics is required by mainstream business applications plus educational, entertainment, and other applications including the Internet Explorer shell for both Windows 2000 and Windows 2000 Professional.~~

~~All systems except for mobile systems are required to support 3-D acceleration in the graphics subsystem. Each entry in this section indicates by system type whether a particular feature must be implemented if the graphics adapter includes 3-D support.~~

~~For exceptions and requirements for mobile PCs that implement 3-D hardware acceleration, see “Mobile PC Graphics Requirements” in Chapter 6, “Mobile PC 99.”~~

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.5.

14.27 Hardware for desktop system supports ~~required~~ RGB rasterization

In RGB mode under Direct3D, shading across a surface is accomplished by independently interpolating all color components. The following capabilities are required for red-green-blue (RGB) rasterization:

?? **14.27.1 Basic 3-D requirements.** To meet basic 3-D requirements, the adapter and driver must do the following:

?? Support ~~800~~ 1024 × ~~600~~ 768 × 16 bpp, double buffered, with 16-bit Z buffer at ~~75~~ 85 Hz in full-screen, 3-D graphics mode

?? All required features must be available at the same time; for example, it is not acceptable to turn off specular highlights in order to enable fog

?? Conform to Direct3D rasterization rules

Mobile PC Note

Mobile systems must support resolutions and refresh frequencies up to the native panel capabilities only.

?? **14.27.2 Textures.** These include the following:

?? MIP-mapped textures

?? Bilinear or better filtered textures, rather than point-sampled, with perspective correction

?? Anisotropic filtering

?? **14.27.3 Alpha blending for 3D graphics.** Source alpha blending is required, and destination alpha blending is recommended. As a minimum, the following source blend modes are defined in the DirectX DDK are required:

~~Required~~	~~Recommended~~
?? D3DBLEND_DESTCOLOR	~~D3DBLEND_BOTHINVSRCALPHA~~
?? D3DBLEND_INVDESTCOLOR	~~D3DBLEND_BOTHSRCALPHA~~
~~D3DBLEND_INVSRCALPHA~~	~~D3DBLEND_DESTALPHA~~
~~D3DBLEND_INVSRCCOLOR~~	~~D3DBLEND_INVDESTALPHA~~
?? D3DBLEND_ONE	~~D3DBLEND_SRCALPHASAT~~
~~D3DBLEND_SRCALPHA~~	
~~D3DBLEND_SRCCOLOR~~	
?? D3DBLEND_ZERO	

For source RGB alpha blending, transparent primitives are blended with the background, but the background transparency is not updated. This method provides good visual accuracy if there are not too many overlapping transparent objects.

If destination alpha blending is implemented, the following destination modes are required:

?? D3DBLEND_SRCCOLOR

?? D3DBLEND_INVSRCCOLOR

?? D3DBLEND_ONE

?? D3DBLEND_ZERO

For destination RGB alpha blending, primitives are blended with the background, updating not only the colors in the frame buffer but also a cumulative transparency that can affect the rendering of subsequent primitives.

?? **14.27.4 Lighting and fogging.** These requirements include the following:

?? Flat and Gouraud shading.

?? Depth-based (Z-based) fog of an arbitrary color, calculated on a per-vertex basis. Depth is defined as distance perpendicular to the screen.

?? Specular highlighting.

The Direct3D reference rasterizer provided in DirectX 5.0 and later supports all of these capabilities.

There is no requirement for edge anti-aliasing. ~~See the following recommendation.~~

14.28 Hardware for desktop system supports~~recommended~~ RGB rasterization features

Note: This item will be combined with the previous in the next draft.

The ~~recommended~~required RGB rasterization features include the following:

?? Range-based ~~and~~or table-based fog

?? Hardware support for triangle strips and fans

Support for the following is encouraged, but not required:

?? Sort independent edge anti-aliasing

?? Precision line drawing ~~(Bresenham line drawing algorithm recommended)~~

14.29 Hardware supports multi-texturing

Multi-texturing hardware can apply multiple textures to a polygon. The most common application of multi-texturing is with map-based techniques for diffuse lighting and specular reflections.

Implementing this capability requires supporting two or more sets of independent texture coordinates. OEMs are encouraged to ~~It is recommended that hardware~~ support~~s~~ combining at least two textures in a single pass.

The following texture combination operations are required:

?? MODULATERGB: Component-wise multiplication of both texture colors.

?? MODULATELPHA: Multiply colors of one texture by the alpha of the other.

?? ADD: Component-wise addition of both textures.

?? BLEND: Linear combination of textures weighted by a scalar specified in a register or in a polygon alpha.

Multi-texturing is used to compute the texture value that participates in the pixel pipeline implemented in Direct3D ~~in DirectX 5.0. It is independent of the alpha blending stage in a previous version of Direct3D~~.

This technique should work in combination with fogging and alpha blending, but is not required to operate at the same time as other advanced filtering.

For more information, see the paper on multi-texturing and DirectX available on the web site at http://www.microsoft.com/hwdev/video/.

14.30 Hardware supports texture formats

Hardware that implements 3-D acceleration must support palletized textures. Pallet entries use the corresponding nonpalletized formats shown in the following table.

Required	Recommended
1:5:5:5 ARGB	48-bit palletized
4:4:4:4 ARGB	8:8:8:8 ARGB
	0:5:6:5 ARGB
	4:2:2 YUV

14.31 Hardware complies with texture size limitations

MIP mapping requires that textures of size 1 × 1 be supported. To meet PC 2001 requirements, a 3-D accelerator must support this lower limit on texture size.

The texture units must support square and non-square power-of-two textures ($2^n \times 2^m$) up to ~~256 × 256.~~512 × 512.

~~Recommended:~~ The texture unit should support non-power-of-two width and height. This enables the texture mapping unit to be used to emulate blts. Also, ~~it is recommended that~~ the texture unit support an upper limit of 2048 × 2048 rather than the required ~~256 × 256.~~512 x 512.

Mobile PC Note

Mobile systems must support square texture sizes of up to 256x256 only.

14.32 [DELETED]~~Hardware supports destination RGB alpha blending~~

14.33 Hardware for desktop system supports Z comparison modes and Direct3D-compatible formats

The 3-D hardware ~~should~~ must support 16-bit minimum, (32-bit with 24-bit Z and 8-bit Stencil recommended), unsigned, lockable Z buffer format and all Z comparison modes.

Hardware ~~that supports Z buffering~~ must support clearing of the Z buffer through the DirectDraw depth-fill blt mechanism. Additionally, DirectX 5.0 (and later versions) enables Z buffers to be cleared at the same time as destination surfaces, so ~~It is recommended that~~ hardware must support simultaneous clearing of color and Z buffers using this method as well.

14.34 Hardware for desktop system meets PC 2001 3-D accelerator performance requirements

The 3-D rendering subsystem should have triangle setup capability implemented in hardware that is capable of processing triangles at a sustained rate in excess of ~~1~~4 million triangles per second.

Each triangle is assumed to be 1 visible pixel in area, random-orientation, front facing, single-textured, and composed of three vertices, where each vertex contains a diffuse and specular color component. Rendering conditions should be 16 bpp, double-buffered, Gouraud shaded bilinear single-textured, Z buffered, and alpha blended. Triangles should be ordered such that the Z check always passes (the current triangle is in front of all previously rendered triangles).

The 3-D rendering subsystem should be capable of filling triangles at a sustained rate in excess of ~~40~~160 million pixels per second. Each triangle is assumed to be 10,000 visible pixels in area (post-clipped), with the same attributes as described for triangle setup in the previous paragraph. Rendering conditions are also the same as for triangle setup. Supporting ~~60~~240 million pixels per second is recommended.

Mobile PC Note

Mobile systems requirements are reduced to 2 million triangles per second and 80 million pixels per second.

Television Output Requirements

This section summarizes the key design issues and requirements for television output capabilities~~, which are recommended for all PC 2001 system types, particularly any PC system that does not include a large-screen entertainment monitor~~.

The required support allows an NTSC or PAL television to be used as a primary~~or secondary~~ display surface for the Microsoft Windows family of operating systems and for Windows-based applications. If television output capabilities are provided in a PC 2001 system, support is required for either NTSC or PAL standards. For more information about world television standards, see the web site at http://www.bbc.co.uk/aberdeen/eng_info/.

Note: The requirements in this section apply only if the television output capability is present on a PC 2001 system or on a graphics adapter that supports television output capabilities. ~~Some television output capabilities listed in this section are required only for Entertainment PC systems.~~

14.35 [DELETE] ~~Adapter supports both NTSC and PAL output~~

Recommendations are not included in PC 2001

14.36 [DELETED] ~~Default boot mode supports appropriate locale~~

14.37 If TV Out is implemented, adapter supports underscan scaling

The television output adapter must be able to correct horizontal and vertical overscan using hardware scaling. ~~This allows 640 × 480 resolution modes to fit onto NTSC displays and 800 × 600 resolution modes to fit onto PAL displays.~~

~~Driver software must be capable of enabling and disabling scaling and also of adjusting scaling for compatibility with a variety of television monitors. As television monitors age, overscan reduces, so less scaling is required.~~

14.38 If TV Out is implemented, adapter supports flicker filter

The television output adapter must use multi-line (3-tap minimum) hardware filtering techniques for flicker reduction. Enable, disable, and adjust capabilities for the flicker filter must be software controllable. Also, overscan ~~should~~ is required to be software controlled.~~enabled when the PC is playing full-screen video.~~ The practice of running the graphics surface at a high resolution and then performing high-quality anti-aliased down scaling to TV resolutions is a good idea and is highly encouraged. ~~For mobile PCs, the television output adapter must use 2-tap minimum hardware filtering techniques or better.~~

14.39 [DELETE] ~~Adapter provides proper termination~~

14.40 If TV Out is implemented, adapter supports composite video~~and S-Video~~ connectors

Support for ~~both~~ composite video is required.~~and S-Video is required for Entertainment PCs and is recommended for other system types.~~

In addition, vendors are encouraged to provide support for S-Video and Component Video connectors. Compared to composite video, S-Video dramatically improves the picture quality of the NTSC or PAL scan converter. This standard is designed to reduce cross talk between chrominance and luminance signals, and to increase the luminance bandwidth capability of the television. A further increase in quality is obtained by using component video, which is common in Europe and will become so in North America.

For information about these standards, see the web site available at http://www.bbc.co.uk/aberdeen/eng_info/.

14.41 If TV Out is implemented, adapter with television output supports ~~both~~DVI or VGA and television output

In addition to television output, the PC 2001 system must also support ~~VGA output to ensure that users with large-screen VGA monitors can use this output capability.~~either DVI or VGA.

~~It is recommended that~~ The adapter should support simultaneous television output and DVI (digital and analog) output.

~~? Simultaneous output to VGA monitor and television.~~

~~? Two display controllers or an implementation that provides the desired result of two independently timed outputs to different monitors.~~

~~With a single controller, both the monitor and television must use a 60 Hz, low-resolution format; which is not desirable.~~

Mobile platforms that support TV Out do not need to support additional VGA or DVI connectors as a flat panel display is presumably already integrated into the platform.

14.42 If TV Out is implemented, software supports positioning

Software must be able to program the television output hardware to position the television image in increments of 4 pixels horizontally and 4 scan lines vertically (or finer).

14.43 If TV Out is implemented, software supports detection of television connection

~~For Consumer PC and Entertainment PC systems,Software must be able to detect whether a television is attached to any of the TV-Out connectors. Detection of a VGA monitor is based on requirement 14.13, "Adapters supports DDC monitor detection."~~Television output must be on by default or the adapter must automatically detect when a TV is connected and turn on the TV out. ~~Detection of a television connection is required to allow the operating system and graphics drivers to correctly support display output during the startup sequence, for example, determining what resolution and refresh rate to use, and to allow applications to adjust their user interfaces appropriately to the screen capabilities.~~

Mobile PC Note

Mobile systems do not have to meet this requirement.

14.44 If TV Out is implemented, analog video outputs support copy protection

The use of an appropriate copy protection system is necessary to ~~stop DVD discs from being played on the PC and then recorded on a VCR.~~ make it difficult for typical consumers to make analog recordings of copy protected content, such as protected DVDs.

Details for MacroVision protection for DVD are available at http://www.macrovision.com.

Plug and Play Requirements for Graphics Adapters

The items in this section summarize requirements for Plug and Play and other resource- and bus-related capabilities. The specifications in this section are required for all PC 2001 systems.

See also requirement 14.11, “Graphics operations use relocatable registers only.”

The requirements in this section ensure easy configuration.

14.45 Display devices do not use VGA BIOS POST to populate PCI SVID ~~Each device has a Plug and Play device ID~~

NOTE TO REVIEWERS: The general PnP device ID requirement is applies for all PC 2001 devices. Title change reflects focus for graphics subsystem

~~The device must have a unique device ID using the format required for its bus. For example, a PCI device must comply with PCI 2.1 and provide a Subsystem ID and Subsystem Vendor ID, as defined in Chapter 9, “PCI.”~~

Multiple-monitor support allows Display class devices to be initialized independent of the system initialization process. For this reason, system-board and add-on display devices cannot use the VGA BIOS POST routine to populate the Subsystem Vendor ID because the device’s POST code might not be executed until later in the process, after device enumeration occurs. For system-board devices, the system BIOS should populate the Subsystem Vendor ID at power on. Add-on display adapters should provide a method for populating the Subsystem Vendor ID at the point when power is applied and the device is initialized to the state that is ready for POST.

14.46 System supports conflict resolution, VGA compatibility, and extended registers

When the end user changes or adds a graphics adapter to the system, setting resource assignments must not require changing jumpers or switches on either the card or the system board. The system must be able to automatically relocate the resources used by a graphics adapter on the system board when a graphics adapter expansion card is added to the system. In the event of an irreconcilable conflict with other devices on the system, the system must be able to disable one of the adapters in order to prevent the system from stalling.

The system must support the VGA graphics standard for application compatibility and for the Windows clean-boot error-recovery process. If a VGA BIOS exists on the graphics adapter, it must be able to configure its base address to C0000h and one alternate address, at a minimum, to prevent conflicts.

Extended resources are additional I/O ports, direct-access frame buffers, or data transfer areas on a graphics adapter that use more resources than does standard VGA. The Windows configuration manager must be able to map the resources to

avoid conflicts with other system devices. At least one alternate configuration must be provided for each non-VGA display resource in the event of conflict during the IPL boot.

The software drivers and VGA BIOS (if used) must be able to use alternate configuration register addresses. The system must be able to dynamically disable or relocate VGA resources from C0000h. It must also be possible to re-enable these resources upon system reboot or reset.

For additional related requirements for multiple monitor support, see "Multiple-Adapter and Multiple-Monitor Support" earlier in this chapter.

BIOS and Option ROM Guidelines for Graphics Adapters

The requirements in this section relate to BIOS support for graphics adapters.

Note to Reviewers: Requirements for systems with integrated CPU/graphics solutions may be different from those of systems with dedicated graphics solutions. Details will be resolved by rev. 0.5.

14.47 Chips support linear packed-pixel frame buffer, relocatable above 16 MB

Note: For DirectDraw, the graphics adapter's chip set must support linear access to the frame buffer by the host.

Windows operating systems are optimized for a graphics adapter with a packed-pixel frame buffer at all supported resolutions. Memory-mapped packed-pixel frame buffers also provide a fast and simple interface between Windows and the graphics adapter. The Windows DIB engine provides a very fast display by writing directly to packed-pixel frame buffers~~; t~~. This architecture requires that the hardware developer write only a small, simple device driver.

For optimized support with Windows, a linear packed-pixel frame buffer is required over a bank-switched frame buffer. Use 32-bit addresses to allow the linear frame buffer to be placed above the 16-MB ISA boundary, which enables a system to be populated with large amounts of RAM.

If memory or other resources conflict with the frame buffer being mapped into a linear address space, the page frame address can be used with minimal degradation of performance.

14.48 Option ROM supports DDC2B

The option ROM for the graphics adapter must meet current DDC2B host requirements documented in *Display Data Channel Standard, Version 3.0*, Level 2B protocol (DDC2B), published by VESA. This standard defines the functions that support the data channel between the graphics adapter and a DDC monitor.

Mobile PC Note

This is not a requirement for mobile systems. For information about exceptions for permanently attached display monitors, see requirement X.Y, “External graphics adapter interface supports DDC monitor detection.”

~~**[14.49] [DELETED][MOVED] BIOS setup utility provides option to force use of system-board graphics**~~

Recommendations are not included in PC 2001. This becomes a requirement for Mobile Systems.

14.50 BIOS supports large frame buffers for graphics adapters

The BIOS must support large frame-buffer graphics adapters that have up to 256 MB of frame buffers.

Requirements for AGP and PCI Graphics Adapters

The requirements in this section apply for graphics adapters that use the PCI bus.

14.51 AGP meets PC 2001 implementation guidelines

New requirements for AGP may be defined in the next version of these draft guidelines. AGP requirements may also move to the Buses chapter in a future draft.

14.52 ~~PCI~~ Graphics device supports IRQ and correctly populates PCI BARs

Proper IRQ support is needed for optimal support of video playback. The display driver queries the actual device to find its register locations and so on. The PCI base address registers (BARs) must be populated correctly for this information to be correct in the registry.

On adapters that do not support an IRQ, the Interrupt Pin Register (3Dh) should be zero (0).

14.53 ~~PCI~~ System-board graphics device is not hidden from Plug and Play enumeration

The system-board device must disable the PCI device rather than hiding it. Hiding the system-board graphics adapter from the PCI bus when another graphics adapter is detected in the system causes problems for supporting multi-monitor capabilities.

Power Management for Graphics Adapters

This section summarizes the specific power management requirements for graphics adapters.

14.54 Graphics adapter complies with device class power management reference specification

The *Display Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions of the OnNow device power states (D0–D3) for display and graphics devices. The specification also covers device functionality expected in each power state and the possible wake-up event definitions for the class, if any. Power states D0 and D3 are required; D1 and D2 are optional for graphics adapters.

14.55 Graphics adapter complies with VBE/Core 2.0 extensions for power management

The *VESA BIOS Extension Standard/Core Functions 2.0* (VBE/Core 2.0) specification defines extensions to VGA ROM BIOS services for power management.

Device Drivers and Installation for Graphics Adapters and Video Devices

This section summarizes the requirements for graphics adapters. The requirements in this section are required for all PC 2001 devices.

For additional driver-related requirements for multiple-monitor support, see "Multiple-Adapter and Multiple-Monitor Support" earlier in this chapter.

Note: Software provided with graphics adapters designed for use with Windows 2000 must comply with the requirements defined in the drivers section of the Windows 2000 DDK.

14.56 [Redundant] Device drivers and installation meet PC 2001 requirements

This is a basic PC 2001 requirement and is no longer repeated in each chapter.

14.57 Driver does not bypass any Microsoft-provided system components

The driver must not bypass or patch any Microsoft-provided system components. For Windows, this includes Gdi.exe, Kernel.exe, User.exe, Dibeng.dll, Mmsystem.dll, Ddraw.dll, D3d*.dll, and so on.

For Windows 2000, this requirement applies for all files normally installed in the System32 directory. These files include, but are not limited to, Win32k.sys, Ntoskrnl.exe, Gdi32.dll, User32.dll, and Mcdsrv32.dll.

14.58 Applications provided with device meet requirements for Win32-based applications

Any Windows-based applications provided with the device must meet Microsoft requirements for software compatibility as defined in the Microsoft Platform SDK.

14.59 Driver supports dynamic color ~~bit~~ depth and resolution change

The graphics adapter must operate properly and must not fail when asked by the operating system to change the color depth or resolution. A restart must not be required to accomplish this.

Shared Memory Architectures

As integration of graphics into the motherboard chipset becomes common there are several issues that must be addressed in order to have an effective implementation.

[NEW.3] Frame buffer implemented using dynamic allocation of system memory

The goal of this section is to establish requirements for the use of system memory by integrated graphics components. Not more than 1 MB of system may be statically reserved at boot time. Additional frame buffer memory must be allocated dynamically as required and freed when no longer required.

Video Guidelines

This subsection covers video guidelines, including MPEG-2, DTV, video input and capture, and analog TV.

REVIEWERS: The sequence of items in the material has changed from PC 99 System Design Guide, and the following items have been deleted in this new draft because they are either redundant or not relevant for the PC 2001 format. Other deletions are noted in place.

?? 15.1. System meets PC 99 requirements for playback of MPEG-2 video from DVD-Video

?? 15.2. System meets PC 99 requirements for playback of MPEG-2 video from digital TV broadcasts

?? 15.3. System supports PC 99 analog video input and capture capabilities

?? 15.4. System includes analog TV tuner

?? 15.5. System includes digital satellite receiver module

?? 15.6. System includes digital cable receiver module

?? 15.7. System includes ATSC DTV support

?? 15.8. System includes DVB cable, satellite, or terrestrial receiver module

?? 15.9. System includes support for multiple digital TV delivery methods

?? 15.11 MPEG sources such as DVD or a receiver module support bus mastering

?? 15.12 Separate MPEG-2 hardware decoder for high-definition video does not cause PCI bus contention

?? 15.13 PCI-based sources of uncompressed standard-definition digital video support bus mastering with scatter/gather DMA

?? 15.52. Device drivers and installation meet PC 99 requirements

?? 15.53. Software drivers are installed during hardware driver installation

?? 15.54. Applications provided with device meet Win32 requirements

?? 15.55. NDIS 5.0 miniport driver provided for digital broadcast receiver

Baseline Video Features

This section describes basic video features.

A mobile system with a DVD drive and a TFT display is considered a "desktop replacement system," for which most requirements are similar to those of desktop systems. Differences are called out in "Mobile PC Graphics Guidelines." Mobile systems without integrated DVD drives or TFT displays do not need to meet any video requirements.

[NEW.4] System supports basic video capabilities

For all PC 2001 desktop systems (including workstations), all graphics and video capabilities must be fully supported at 1024 x 768, 32 bpp mode or better.

Mobile PC Note

Mobile PC 2001 systems require support of 640 x 480, 16 bpp mode only.

The following video capabilities are also required for all systems:

?? MPEG—1/2 decompression capability.

Mobile systems require MPEG-1 decompression capability only unless system includes a DVD drive in which case MPEG-2 decompression is required.

?? MPEG—1/2 compression capability (TBD)

?? DV decompression capability

?? DV compression capability

?? DVI support

15.17 Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

The driver for any video or tuner/decoder device must use the DirectX foundation class to control all video data. The MPEG-2 decoder must support the

current DirectShow APIs and must support the WDM Stream class driver architecture. The WDM Stream class must be used to support any data streaming. For information, see the DirectX 5.0 DDK and the Windows 2000 DDK. See also "Device Drivers and Installation for Video and Broadcast Components" later in this chapter.

15.48 All video implementations use DirectShow for video routing and processing

Stream splitting should be provided using DirectShow. Stream splitting is done on the host CPU using DirectShow filters in the same manner as support is implemented for DVD video input data streams. All other video processing should use DirectShow, and applications must use DirectShow interfaces.

15.49 [REDUNDANT] Each hardware device has a Plug and Play device ID

This is a general PC 2001 requirement and will not be repeated in separate device chapters

15.50 [REDUNDANT] Dynamic resource configuration is supported for all devices

15.51 Dependent video device is not independently enumerated

If a video device is implemented as a dependent device on a multifunction adapter, it must not be independently enumerated. Instead, its parent must be responsible for installing and loading its driver and for updating the registry on its behalf. See also requirement 3.21, "Multifunction add-on devices meet PC 2001 device requirements for each device."

[New. 5] If DirectShow filters replace any filters included with the operating system, replacements provide a functional and qualitative superset of the replaced modules

Any replacement DirectShow filter must be able to accept the exact same input and output formats provided by the operating system version of the DirectShow filter.

[New. 6] All video input devices use WDM drivers

In a PC 2001 system, video input devices must used Windows Driver Model (WDM) device drivers. For implementation guidelines, see the Windows 2000 DDK.

Note to Reviewers: Details will be provided in a future draft.

[New. 7] All video implementations meet basic video quality requirements

The purpose of this set of requirements is to define how all consumer electronics (CE) high quality TV style video streams must be treated as a whole or by components. The effect should be that the source quality is preserved during

playback, storage, or processing of the video streams and overall PC performance is not adversely affected.

The requirements apply to all playback and recording solutions. Excepted are solutions that are serviced by non-isochronous video sources (internet), solutions that utilize inherent quality tradeoffs (conferencing cameras, dongles that convert TV style video into conferencing style video or still video). Also excepted are solutions that provide some video functions for monitoring purposes only and not for recreational viewing such as monitor video windows (outputs) of video editing solutions. CE video guidelines do not apply to mobile systems.

Examples of CE quality video sources are NTSC at 720x480 x 29.97 fps and PAL at 720x576 x 25 fps, 4:2:2. Other resolution and frame rate combinations may be subject to the same requirements, depending on the source, but only if the source resolution does not exceed the overall pixel rate of the above example (approximately 10.5 Mpixels/s). Video sources with higher pixel rates may cause system performance that scales down as pixel rate scales up.

The requirements include the following:

Note to Reviewers: Details will be provided in a future draft. These items can be expected to be expanded as separate requirements.

?? **[New.7.1]** TV-style video source frame and field rates must be preserved to memory and to the display. [15.21.1]

?? **[New.7.2]** TV-style video source resolution must be preserved to memory and to the display.

?? **[New.7.3]** TV-style video source quality must be preserved to memory and display.

?? **[New.7.4]** TV-style video source color information must be preserved to memory and to the display.

?? **[New.7.5]** TV-style video source video aspect ratios are preserved and displayed correctly. [15.21.4]

?? **[New.7.6]** TV-style MPEG-2 video stream playback consumes less than an average of 35 percent of CPU measured during any given minute.

Mobile PC Note For mobile PCs, 50 percent average is acceptable.

?? **[New.7.7]** TV-style MPEG-2 video stream playback consumes less than 35 percent of memory, PCI, or AGP bandwidth during any given minute.

Mobile PC Note For mobile PCs, 50 percent average is acceptable.

?? **[New.7.8]** TV-style video stream playback is audio-video synchronized to within 75 ms. Audio-video synchronization drift is corrected without violating the specifics of the frame/field rate requirements. [15.21.2]

?? **[New.7.9]** Baseline video requirements must be maintained for simple playback in any environment with additional workloads of less than 35 percent average

CPU, memory, PCI, or AGP utilization during any given minute and with peak utilizations that exceed 35 percent lasting less than 15 ms and not occurring more than once during any given second.

Mobile PC Note Mobile PCs do not have to meet this requirement.

?? **[New.7.10]** Video is made available through input or transform filters in the YUY2 and YV12 4cc color formats while maintaining all other baseline video requirements.

?? **[New.7.11]** All video streams that enter the system as "content protected" and can be streamed out to an analog output must be analog copy protected.

?? **[New.7.12]** Displayed video that enters the system interlaced but carries a tag identifying how the video fields were derived from a progressive source will be de-interlaced using the weave method. It is recommended that de-interlacing is performed by the graphics subsystem.

?? **[New.7.13]** Displayed video that enters the system interlaced but carries a tag identifying the video source as 24 fps film will be (in combination with weave de-interlacing) played back using a suitable frame rate increasing process such as 3:2 pulldown or better. It is recommended that the graphics subsystem performs the required pull-down or upsampling.

?? **[New.7.14]** Displayed video that enters the system interlaced and carries either no identifying tag or is tagged as interlaced material should be de-interlaced by the graphics subsystem using the bob method or a method superior to the bob method. De-interlacing may also take place outside of the graphics subsystem.

?? **[New.7.15]** When video is displayed on a monitor that is refreshed at a different rate than the field/frame rate of the video stream then an optimal frame repeat pattern must be selected.

Digital Video Support Guidelines

This section presents digital video guidelines.

Note to Reviewers: Details will be provided in a future draft.

15.10 System supports DV decoding and encoding

A digital video compression codec is necessary for displaying video from digital camcorders and for compressing video from other sources. Typically the digital camcorder will supply digital video-encoded (DV-encoded) video to DirectShow. DirectShow includes a software DV codec that can provide the necessary functionality. Although this means that hardware DV decoding is not required, hardware decoding can be used to improve performance or lessen CPU loading. Other video data compression schemes can also be used.

MPEG-2 Video Playback Guidelines

This section presents MPEG-2 playback guidelines.

15.14 All MPEG-2 decoders can accept an MPEG-2 elementary stream

DirectShow provides the selection and de-multiplexing of MPEG transport streams and program streams. Stream filtering in hardware can be used to aid this process. DirectShow feeds the appropriate video stream such as ~~Packetized~~ Elementary Stream ~~(PES)~~ to the MPEG decoder. The decoder must be able to take MPEG in that form. PES format support is also required without reliance on any packet sequence numbering ~~is a requirement~~. Nonreliance on packet sequence numbering is necessary to support applications where packet sequence numbers cannot be created, for example, when audio and video come from separate sources, such as video from disc synchronized to audio from the Internet.

15.15 All MPEG transport stream information is available to the central host processor

MPEG streams can come from a number of sources, including different PCI receivers, Device Bay-based receivers, a set-top box, a set-top computer, a network such as the Internet, or a video-conferencing camera, and so on. DirectShow provides support for selecting the required MPEG streams, de-multiplexing them, and feeding them to the appropriate decoder or subsystem. Stream filtering in hardware can be used to aid this process. Video quality standards must be maintained when streams are being routed via the host processor.

~~Recommended: When possible,~~When Conditional Access systems allow it, the transport stream de-multiplexing is required to be performed by the central host processor.

In the same way that it sends the video to the video decoder, the host software (comprising DirectShow and other components) also sends the audio to the audio decoder and the data services to the appropriate place. This is fundamental to the architecture for digital TV on PCs. On a particular PC, each subsystem could be implemented in software, hardware, or a combination of the two. The operating system needs to be able to manage all the different configurations.

It is not acceptable to implement an “around the side” hardware path from the receiver to the MPEG decoder. The requirement that all digital compressed video streams are routed using the central host software will also make it easier to migrate to video-capable home network environment, where the receiver functions and display functions will typically be in completely separate boxes. It is also fundamental for features such as ~~automatic program recording.~~intelligent TV timeshifting.

15.16 [DELETE] Background tasks do not interfere with MPEG-2 playback

15.17. [MOVED] Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

Appears later in this chapter

15.18 [DELETE] All components meet PC 99 general device requirements

15.19 [DELETE] MPEG-2 MP@ML playback meets PC 99 requirements

15.20 [DELETE] MPEG-2 playback for ATSC, DVB, or other digital TV systems meets requirements

15.21 [DELETE] MPEG-2 video decode implementations meet quality requirements

Some components appear elsewhere in the quality requirements for [New.5] "All video implementations meet basic video quality requirements"

15.22 [DELETE] De-interlacing of standard-definition video meets requirements

15.23 If implemented, MPEG-2 decoder supports the pull-down algorithm

An MPEG-2 software or hardware decoder should be able to detect and behave accordingly when 3:2 pull down is being used to display 24-fps video. The kernel-mode video transport component in DirectDraw requires this information from the decoder in order to know when a particular redundant field algorithm is being used so it knows which fields to skip.

For more information, see the DirectX DDK.

DVD Video Playback Guidelines

Note to Reviewers: Details will be provided in a future draft.

The following requirements apply for systems that provide DVD-Video playback software and hardware. The goal for DVD and other audio/video (A/V) playback is to ensure that the end-user experience is the same or better than with a stand-alone DVD player.

15.24 If DVD-Video playback is implemented, DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment

Vendor-supplied minidrivers for DVD, MPEG-2, and AC-3 decoders must:

?? Use the correct media types, including validation of all format block fields on connection and on every IPin::QueryAccept message.

?? Query for IMediaSample2 on every received media sample to test for a time discontinuity bit.

It is also acceptable to query on every video/audio frame to reduce CPU overhead.

?? Adjust the decode rate in response to IPin::NewSegment () calls for video and subpicture.

For details about APIs, see the DirectShow documentation in the Microsoft Platform SDK.

15.25 If DVD-Video playback is implemented, DVD decoder supports subpicture compositing and closed captioning

Mobile PC Note For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.

The system must be capable of displaying subpicture data as well as providing closed-captioning support for all such data stored on the disc. This requires YUV offscreen overlay surface support as defined in requirement 14.14, "Hardware supports video overlay surface with scaling."

Subpicture streams must be supported as defined in *DVD Specification, Version 1.0,* from Toshiba Corporation.

Note: Alpha blending, or a driver-implemented simulation implemented in the driver, is required for static menus.

15.26 If DVD-Video playback is implemented, subpicture decoder correctly handles subpicture properties and other functions

Mobile PC Note For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.

The minidriver for the subpicture decoder must be able to:

?? Set the subpicture properties

?? Turn the subpicture compositing on and off

?? Set the highlight rect parameters

For more information, see the Microsoft DirectX SDK and the DirectX information in the Windows 2000 DDK.

15.27 If DVD-Video playback is implemented, system supports seamless DVD-Video 1.0 navigation

Mobile PC Note For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.

This requirement includes menu navigation, video selection, and language and subpicture track selection in support of the user's ability to navigate DVD-Video discs. ~~Test sources must include, but are not limited to, the following:~~

~~? Matsushita Electronics Incorporated (MEI) test disc~~

~~? Joe Kane Productions Video Essentials disc~~

For any system capable of playing back a DVD-Video title, DVD playback must ~~use~~work with the latest released version of the Microsoft DirectShow Navigator/Splitter filter and other DirectShow test filters to ensure that it conforms to the input and output standards established by the Microsoft Navigator/Splitter. In particular, it must ~~use~~work with the most recent versions of the following:

?? IDvdGraphBuilder

?? Microsoft DirectShow DVD Navigator

?? Microsoft DirectShow Overlay Mixer

The requirement to ~~use~~work with the DirectShow Navigator/Splitter filter is not intended to preclude the use of differentiating product features and enhancements.

[NEW.8] DVD-Video player provides seamless and gapless DVD navigation

All DVD-Video players must navigate chapter breaks seamlessly and gaplessly. This requirement holds true even if the underlying elementary streams were created as separate PGC objects. If the navigation calls for a seamless transition, then for any legal GOP structure, bit rate, or both, the player must deliver.

For PC2001, this player requirement is extended to allow the layer break position to be placed independently, without regard to the type of chapter navigation used. Classically, the layer break is only allowed during non-seamless transitions.

Although not explicitly allowed in the formal DVD-V specification, seamless chapter break transitions span the layer break on some popular DVD features. Therefore, the DVD PC must be able to flawlessly reproducing seamless chapter breaks that are co-located with layer transitions, just as if the layer break weren't there.

Note to Reviewers: Is flawless transition possible? May require pause, etc., similar to DVD consumer players. Can we define "flawless".

15.28 All DVD video decoders must support Line21 closed-caption data

All DVD video decoders must support Line21 closed-captioned data output compatible for use with the DirectShow Microsoft Line21 decoder filter. In addition to ensuring closed-captioned output for the hearing impaired, it enables applications that use the Line21 channel on DVD as a data channel for non-Line21 data.

15.29 [DELETE] System provides a licensed CSS copyright protection scheme

Video Input and Capture Guidelines

Note to Reviewers: Details will be provided in a future draft.

This section summarizes requirements based on capabilities that support video capture in the Windows 98 and Windows 2000 operating systems. If analog video capture is implemented, the requirements in this section must be met.

15.30 [DELETE] Analog video decoder such as NTSC/PAL/SECAM meets quality requirements

15.31 If implemented, analog video capture device outputs video data at 3.7 MB/sec, minimum

Systems with capture devices must be capable of capturing 3.7 MB per second to disk. Increasingly it will be necessary to compress the digitized analog video (that is, MPEG encode) in order to allow the video to pass to the host processor so that the host processor can add value such as Intelligent TV Timeshifting.The compression can be done in hardware, software, or increasingly in the future using hardware accelerated software.

15.32 If implemented, video input or capture device provides raw sampled VBI data to the host

The ~~raw~~ vertical blanking interval (VBI) data (uncorrupted by any video processing) must be ~~decoded in~~made available to the host processor ~~software~~ to provide enhancement data, web pages, and information about elements such as video formats and time code.

15.33 [DELETE] Digital video camera uses external bus support

15.34 [DELETE] Video input image orientation identification meets requirements

Analog TV Tuner/Decoder and VBI Capture Guidelines

Note to Reviewers: Details will be provided in a future draft.

This section defines requirements for analog TV tuner/decoder capabilities and VBI data capture capabilities in support of the Windows Broadcast Architecture.

15.35 [DELETE] Analog TV tuner/decoder supports PC 99 audio and video performance

15.36 [DELETE] Analog TV tuner/decoder includes stereo audio decoder and supports SAP

15.37 If implemented, VBI capture oversamples VBI data at least four times

To ensure accurate data reception, data transmitted on all lines of the VBI must be oversampled at least four times the NABTS data bit rate (or locale-specific data bit rate). For example, if there are 288 bits of NABTS data on a scan line, approximately 1,152 one-byte samples, plus the necessary margin, must be captured per scan line. This represents the number required for timing tolerances in the NABTS specification and also for timing uncertainties within the capture hardware. Five times oversampling provides the most robust solution when the signal quality is poor.

15.38 [DELETE] ~~VBI capture makes VBI data available to the CPU for processing~~

Digital Broadcast TV Guidelines

The requirements in this section apply for any system that implements a digital broadcast subsystem, whether receiving satellite, cable, or terrestrial broadcasts.

It is expected in that the receiver modules will be implemented in the following form factors: Device Bay modules, PCI modules, external modules or set-top boxes using the IEEE 1394. A receiver module that is limited to low bit-rate transmissions, less than 5 Mb/s, could be implemented using standard USB. Device Bay is a good solution for receivers requiring conditional access systems, but conditional access systems can also be implemented with any of the other receiver types.

Digital broadcast and satellite support as defined under these guidelines includes all the requirements for hardware decoder capabilities and driver support as defined in this chapter, plus support for the DirectX foundation class, as defined in the Windows 2000 DDK.

15.39 If implemented, digital broadcast module can receive all streams contained in the particular transport stream

This can be a receiver for cable, satellite, or terrestrial, and other digital TV broadcasts. The receiver module must provide data tuning, demodulation, conditional access, and other network-specific functions.

The receiver module must be able to receive both normal broadcast network-related information, such as MPEG video, audio, and program guide information, as well as data-stream information.

The receiver card must provide a way to allow the host to obtain PCR and other transport stream fields, such as the discontinuity indicator bit, when the card is performing PES packet building. In this mode, the relevant information must be made available by the driver to the host. In addition, the receiver card must provide a mode in which the host can obtain full MPEG-2 transport or program stream headers, and data for selected elementary streams.

15.40 If implemented, digital broadcast module can receive full bandwidth from each frequency

The receiver module must be able to receive all information transmitted on any tuner or transponder frequency. If de-multiplexing is performed on the receiver module, the stream selection and routing must be controlled by software running on the host processor.

15.41 If implemented, digital broadcast module can receive a minimum of ~~16~~ 32 simultaneous elementary streams

The receiver module must be able to simultaneously receive on the same carrier frequency and send to the host either a transport stream or the complete set of elementary streams and accompanying data. Any receiver doing transport stream ~~splitting a~~splitting, for example, a receiver that provides a proprietary conditional access ~~scheme must~~scheme, must support a minimum of ~~sixteen~~32 elementary streams being sent to the host. The streams can be of any type, such as ~~sixteen~~32 simultaneous data streams. These streams, identified by unique service channel IDs (SCIDs) or program IDs (PIDs), are subdivisions of bandwidth on a single tuner frequency.

The receiver module must provide a means for the host processor to control the de-multiplexing of the transport stream (containing the multiple data streams) or pass the complete transport stream to the host processor for software de-multiplexing. The fundamental ~~criterion~~requirement is that the resulting MPEG elementary streams are routed by the software running on the host processor.

~~Recommended: More than 24 simultaneous elementary streams.~~

15.42 [DELETE] ~~System can simultaneously receive two or more broadcast frequencies~~

Recommendations are not included in PC 2001

15.43 If implemented, digital broadcast module provides support for conditional access

Receiver modules should support conditional access mechanisms for any subscriptions, pay-per-view events, and other network-specific access-control mechanisms available on the broadcast services for which they are designed.

In many cases, this is a removable smart card that has been paired with code and run on a secure processor on the ~~card.~~receiver module. Device Bay provides a convenient way of incorporating a smart card slot, but it is not the only way.

For the separate yet related issue of copy protection, the link from the receiver to the host must be a secure link. It must conform to whatever copy protection ~~scheme is~~requirements are mandated in connection with the terms for the conditional access.

15.44 [DELETE] ~~Digital broadcast module provides signal quality and other diagnostic information~~

Recommendations are not included in PC 2001

15.45 [DELETE] ~~Digital broadcast receiver module supports general-purpose data cryptography~~

Recommendations are not included in PC 2001

15.46 [DELETE] ~~Digital broadcast receiver module supports stream filtering~~g

Recommendations are not included in PC 2001

15.47 If implemented, ATSC DTV tuner/demodulator is fully implemented

If an ATSC DTV tuner/demodulator is implemented, it must meet the requirements for packetized data transport structure, and modulation and transmission systems as specified in *ATSC Digital Television Standard* (A/53), available at http://www.atsc.org.

15.48 [DELETE] ~~Stream splitting is supported using DirectShow filters~~

Recommendations are not included in PC 2001

Tethered Video Device Support:

Tethered video devices, such as digital video cameras using the USB bus or USB dongles that convert camcorders into virtual digital video cameras are considered low-cost solutions to support video conferencing and low-resolution video authoring. Such devices are exempt of the baseline video requirements. Devices that claim to support “full motion video” or similar quality are not considered tethered video devices and must meet all baseline video requirements. IEEE 1394 DV-based devices are not considered tethered video devices.

Note to Reviewers: Please comment on how these proposed requirements affect your product roadmap.

[New.9] Tethered video devices must support video modes of at least CIF at 15 fps or better

(Resolution frame rates are verified to meet requirement.)

[New.10] Tethered video devices must support the YV12 and IYUV FOURccs and formats

Capture driver supports YV12.

[New.11] USB camera does not utiltize more than 5 Mb/s USB bandwidth at 15 fps CIF

Details to be provided in a future draft.

Graphics Subsystem Support for Video

This section presents requirements for the graphics subsystem to support TV or DVD video playback.

Note to Reviewers: Details will be provided in a future draft.

14.14 If support for TV or DVD video playback is implemented, hardware supports video overlay surface with scaling

Mobile PC Note For Mobile PC guidelines, see "Mobile PC Graphics Design" later in this chapter.

It is envisioned that the overlay surface will be implemented using one of the required YUV formats. The graphics adapter must be able to support a minimum of one off-screen video overlay surface that has following characteristics:

?? **14.14.1 Size.** Support for ~~720 × 576~~1440x720 or larger.

~~To support the HD0 formats for DTV—notably 720p24—it is required to support 1280 × 720 on the Entertainment PC.~~

?? **14.14.2 Screen Resolutions.** The video overlay must be fully operative at a minimum screen resolution of 1024 × 768 at 60 Hz and color depths of ~~8 bpp and 16 bpp.~~16 bpp and 32 bpp.

~~Recommended: Full support at 1280 × 1024, with color depths of 8, 16, 24, and 32 bpp.~~

?? **14.14.3 Color formats.** The required formats must include the following:

?? YUV 4:2:2 YUY2: A packed-pixel byte stream for every pixel in the order of Y1, U, Y2, V is required in ~~both the primary and secondary~~all overlay surface buffers.

Recommended: Support for YUV 4:2:2 UYVY: A packed-pixel byte stream for every pixel in the order of U, Y1, V, Y2 is recommended in ~~both the primary and secondary~~all overlay surface buffers.

?? YUV 4:2:0 YV12: A system-board byte stream for the entire plane in the order of Y plane, V plane, U plane is required in the ~~secondary~~ final overlay surface buffer when double-buffering is supported.

If double buffering is not supported, YV12 support must be provided in the ~~primary~~ overlay surface.

Support for the YUV 4:2:0 format is not a requirement if the graphics chip supports on-chip MPEG decoding (that is, 75 percent hardware implementations such as motion compensation and iDCT in hardware solutions, or the equivalent). In this situation, YUV 4:2:0 capability is only a recommendation, although it is still strongly recommended to support software MPEG decoding for secondary video windows.

~~*Mobile PC Note*~~

~~Mobile PCs and Office PCs that implement TV or DVD video playback features are not required to support the YUV 4:2:0 format.~~

~~The YUV color space and intensity range are defined by the ITU-R BT.601-4 standard (previously called CCIR-601), where U is CB and V is CR. These formats use less memory while maintaining high quality, and YUV is the native format for many image and video compression standards.~~

?? **14.14.4 Scaling.** Upscaling and downscaling to any size window. The high~~er~~ quality video scaling can occur anywhere between the video input to the chip, on the AGP, PCI, or side port, and the video appearing on the screen.

Video scaling must be implemented using the existing DirectDraw and DirectShow APIs.

For PCs to effectively compete with dedicated consumer electronics video devices, it is necessary to raise the quality of video scaling on the PC. Specifying scaling quality is hard because of the difficulty of quantifying viewer-perceived video quality. In the absence of anything better, guidelines for the quality of the video filter used in the resizing operations are ~~specified~~ specified.

~~Scaling requirements for video-enabled Office PC or Mobile PC systems:~~

~~? Hardware scaling is not a requirement, but bi-linear scaling (two taps vertically and two taps horizontally) is recommended. However, considerable user and marketplace benefits can be gained by implementing the video playback requirements defined for Entertainment PC systems.~~

~~? Any hardware scaling engine present on a non-DTV-enabled Office PC is required to be able to accept a standard definition video input (480i or 576i), such as might come from a DVD or NTSC source. For a DTV-enabled Office PC, the requirement is that the scaling engine, if one is present, must be able to accept an input with a rate of 480p60 (720 horizontal pixels) and 720p24 (1280 horizontal pixels).~~

~~Scaling requirements for video-enabled Consumer PC system:~~

?? The minimum requirement is to use bi~~-~~linear scaling; a filter with two vertical taps and two horizontal taps is required. ~~Recommended:~~Vendors are encouraged to implement a minimum of three taps vertically and four taps horizontally and, ideally, four or five vertical and seven or eight horizontal taps.

?? The ability for video display to shrink or zoom by a variable factor of up to 8:1 in one-pixel increments is required.

?? The image quality should not be perceptibly degraded when shrinking by factors up to 2:1. Some image degradation is acceptable for the larger shrink ratios, although market acceptance of the product will suffer if image quality is excessively degraded.

?? The scaling engine on a non-DTV–enabled Consumer PC must be able to accept a standard definition video input (480i or 576i), such as input that might come from a DVD or NTSC source. For a DTV-enabled ~~Consumer~~ PC, the scaling engine must be able to accept an input with a rate of ~~480p60 (720~~720p60 (1280 horizontal pixels) and 540p60 (Bobbed from 1080i) ~~720p24 (1280~~(1440 horizontal pixels).

?? The ability to upscale and downscale is required to be implemented in hardware. ~~must be implemented in hardware. Downscaling should be implemented in hardware. Future versions of this design guide are likely to exclude the practice of being able toin the driver.~~

~~Scaling requirements for Entertainment PC systems:~~

~~? The scaling filter (interpolator) is required to implement a minimum of three taps vertically and four taps horizontally.~~

~~Recommended: a minimum of three taps vertically and five taps horizontally be implemented and, ideally, four or five vertical and seven or eight horizontal taps.~~

~~? The ability to shrink or zoom by a variable factor of up to 8:1 in one-pixel increments and the ability to shrink by a variable factor of up to 16:1 in one-pixel increments is required.~~

~~? The image quality should not be perceptible degraded when shrinking by factors up to 4:1. Image degradation is acceptable for the larger shrink ratios, although market acceptance of the product will suffer if image quality is excessively degraded.~~

~~? The scaling engine on a non-DTV-enabled Consumer PC is required to be able to accept a standard input with a rate of 480p60 (720 horizontal pixels) and 720p24 (1280 horizontal pixels).~~

~~-~~The term *tap* is defined here as the number of input pixels that contribute to the building of each output pixel. A bi~~-~~linear filter is two taps, and a three tap filter is a filter better than bi~~-~~linear. For filter designs employing three or more taps, it is desirable to use a “windowed sinx/x” function. However, the “windowing” process needs particular attention, especially when small numbers of taps are used to achieve the best subjective picture quality.

To allow optimization, it is sensible for filter coefficients to be stored in a look-up table with values that are downloadable from the driver. For shrinks greater than a 2:1 ratio, larger numbers of taps are needed or need to be synthesized.

~~An example would be putting shrink factors, such as a halving factor in series with the variable shrink factor specified earlier. When doing shrinks, great care needs to be taken with the filter coefficients to minimize spatial aliasing. High-frequency components in the source should ideally be attenuated by either pre-filtering or adjusting the interpolation filter characteristics.~~

When scaling 4:2:2 or 4:2:0 YUV video, scaling is only acceptable with two-pixel granularity. A method must be employed to present this as one-pixel granularity on window size because users will resize windows with one-pixel granularity. One acceptable method would be to crop a one-pixel strip from the resized video where necessary.

~~Recommended: Additional independent and resizable overlays for support of picture-in-picture (PIP) video features and multiple video conferencing windows are recommended on all system types.~~

~~Future versions of these guidelines are likely to specify higher quality scaling. A particular area of focus is likely to be the quality of back-end upscalers, which will need to increase. An example is an increase to a three-tap by five-tap interpolator for all video-enabled desktop PCs.~~

[New. 11] If support for TV or DVD video playback is implemented, overlay supports YUY2 and YUV12 color space conversion to RGB

Note to Reviewers: Details will be provided in a future draft.

[New. 12] If support for TV or DVD video playback is implemented, colorspace conversion can be configured for different color primary standards

Support is required for the 601 color standard is required. Support is not required for the 709 color standard These are different conversion equations between the YUV and RGB domains.

14.15 Hardware supports VGA destination color keying for video rectangle

This is a requirement for video overlays. The hardware must be capable of independently controlling the VGA pixels for compositing the video plane under the VGA plane. This VGA destination color keying must function in all video modes using either or both of the following:

?? A specific color/color range, for example, on 4-bit, 8-bit, 15-bit~~, and 24-bit~~ SVGA modes

?? Additional alpha blending bits in the color plane bits on 16-bit and 32-bit SVGA modes

Color keying the VGA allows certain VGA pixels to be replaced by the underlying video pixels on a pixel-by-pixel basis. This feature enables VGA video overlays, controls, Windows pop-up menus, dialog boxes, and so on, and it allows for

irregular-shaped graphics compositing. Color keying must work simultaneously with any vertical/horizontal scaling active for the underlying video.

14.16 If support for TV or DVD video playback is implemented, hardware supports alpha blending of graphics and video

Note to Reviewers: Details will be provided in a future draft.

The hardware must support alpha blending for DVD-Subpicture and the user interface (UI) for data-enhanced television.

The DVD-Subpicture stream has 4 bits of alpha information per pixel that indicate how the subpicture should be composited with the main picture. In the future, data-enhanced television streams will also require alpha-composited UI functionality with 8-bit control. With 8 bits, the translucency can be faded in and out, which is important to the creative community. Currently, set-top boxes, such as WebTV® service provide this type of control.

In color modes that support alpha blending, such as ARGB8888, the blend level is controlled on a per-pixel basis. Color modes that do not support alpha blending, such as RGB 565, should allow an overall constant alpha blend value for the overlay.

A minimum of ~~4~~ 8 bits of alpha blending must be provided in any secondary overlay surface when in 32-bit mode, such as ARGB8888. In other color modes, it is acceptable to synthesize the effect within the secondary overlay surface. This can be done using methods such as screen-door dithering using the overlay color key or 1-bit alpha control. Full 8-bit alpha control is defined as a 256-level linear translucency state from 0 percent (value of 0) to 100 percent (value of 255). When fully implemented, linearity should be monotonic with an accuracy within 0.5 bits.

Whatever alpha-blending scheme is implemented, the driver should present it as an 8-bit control.

14.17 Video port meets PC 2001 specifications if present on graphics adapter

Video side ports are not a preferred video architecture for the future. If a side port is implemented, this requirement applies to all graphics adapters that use a video port connection or that enable end users to make such a connection to a video device. The video port is a dedicated connection between video devices, such as the graphics adapter and an MPEG-2, NTSC, or PAL decoder. A video port can be implemented as a hard-wired connection on the same board as the graphics adapter or implemented between separate devices using a cable connection.

Video side ports that have host port or bi-directional capability can provide a useful way to attach additional functionality to the graphics chip. This can be

useful for optional functions and for functions that would not fit on the graphics chip, such as MPEG decoders and high quality de-interlacers.

It is expected that most implementations of graphics adapters will have a single MPEG decoder on the graphics adapter. Providing a side port connector on the card allows addition of other decoders.

For a graphics adapter that includes a video port, the following requirements must be met:

?? **14.17.1 Autoflipping.** The video port must support automated overlay and video port buffer flip on video port vertical synchronization (Vsync).

?? 14.17.2 IRQ. The video port must generate an IRQ when Vsync occurs. The kernel-mode video transport component of DirectDraw version 5.0 and later can use this IRQ to perform autoflips. This capability allows fields to be skipped by the video port and also prevents an irregular synchronization from overwriting its buffers. This also enables capture of vertical blanking interval (VBI) and video port data.

Mobile PC Note This IRQ is not required for mobile PCs.

?? **14.17.3 Driver.** The driver must support DirectDraw Video Port Extension (VPE), which provides a key element of video playback support in DirectX 5.0. This support must be incorporated to ensure that the graphics adapter and video port take advantage of VPE capabilities in the operating system.

For information about implementing DirectX support, see the Windows 2000 DDK. See also the white paper on DirectDraw VPE and kernel-mode video transport at http://www.microsoft.com/hwdev/devdes/vpe.htm.

For additional requirements related to implementing video ports, see “System Requirements for Video and Broadcast Components.”

~~Recommended:~~ The following guidelines for video ports ~~are recommended to~~ support high-quality TV or DVD video playback:

?? **Maximum height.** The graphics adapter should support a register that limits the maximum height of the field that gets written into memory.

?? **Separate pitch and start addresses.** The overlay and the video port should support separate pitch and start addresses. This allows the bob algorithm to be used while the video is interleaved, which makes switching between bob and weave modes possible.

Note: Video side port bus settings are an exception to the general PC 2001 requirement for dynamic resource configuration. These settings might require jumpers to be moved for some sophisticated configurations. Note also that video side port implementations are generally not a good long term architecture.

Mobile PC Graphics Design

This section defines the specific requirements for graphics display capabilities on a Mobile PC 2001 system.

Unless an explicit exception is stated in this section or is noted earlier for specific requirements, the PC 2001 requirements apply for mobile PCs as defined in earlier in this chapter. However, if there is any conflict with requirements stated elsewhere in this guide, the items in this section have precedence for mobile PCs.

Mobile systems without integrated DVD drives or TFT displays do not need to meet any video requirements as defined in "Baseline Video Features."

6.20 Mobile system meets Mobile PC 2001 requirements for supporting multiple adapters and multiple monitors

Multiple adapter support is not required, unless the mobile system supports a full docking station with an additional graphics adapter or user-accessible capabilities for adding one or more graphics adapters.

If a full docking station is implemented, the mobile unit BIOS, graphics adapter, and driver must have support for multiple adapters as defined in the "Multiple-Adapter and Multiple-Monitor Support" section of this chapter." This support allows a user to add a graphics adapter in the docking station.

If the built-in graphics adapter supports attaching an external display, multiple monitor support is optional for the internal adapter. The primary and secondary displays do not need to support independent or simultaneous displays, especially different resolutions of the same image. Compromises are acceptable: other graphics requirements do not need to be met while independent displays are attempted. For example, playing a 3-D game on the internal display while showing an MPEG movie on the external display does not need to perform to normal levels of acceptability or even work at all.

6.21 Mobile system's external graphics adapter interface supports DDC monitor detection

Mobile systems are not required to support detection of the display based on the *Display Data Channel Standard, Version 3.0* (DDC) if the display is permanently attached and connected using an internal interface.

However, mobile systems must support DDC2B if an external graphics interface port is implemented. The complete PC 2001 requirements are defined in requirement 14.13, "Adapter supports DDC monitor detection."

6.22 If MPEG-2 or DVD playback features are implemented, mobile system meets Mobile PC 2001 requirements

MPEG-2, DVD, and DVD playback features are not required for a mobile system.

However, if video playback capabilities are implemented, the mobile system must support the related requirements defined in this chapter with the following exceptions:

?? Support for the video overlay surface must include the following:

  ?? Support is required for only one of the YUV formats defined

  ?? Scaling is not required (including underscan, downscaling, overscan, and arithmetic stretching)

  ~~? Overlay alpha blending in 32 bpp is not required, as defined in requirement 14.16, "Hardware supports alpha blending of graphics and video"~~

  ?? Other requirements apply as defined in requirement 14.14, "Hardware supports video overlay surface with scaling"

?? IRQ support for a video port is suggested, rather than required. Other requirements apply as defined in requirement 14.17, "Video port meets PC 2001 specifications if present on graphics adapter."

?? PAL ~~support is recommended, rather than~~and SECAM support is not required.

  Note: It is not possible to support all video components on PAL with only 2 MB of frame buffer memory.

~~? At least one of the following minimum video performance capabilities is required, in comparison to the performance requirements defined in this chapter:~~

~~? 80 percent of the fields per second at full frame size~~

~~? 50 percent horizontal and 50 percent vertical reduction in frame size at full fields per second~~

~~However, if a mobile system meets the minimum performance requirements defined for an PC 2001 system, then the performance standards apply as defined in "."~~

6.23 If AGP is implemented, system meet Mobile PC 2001 requirements

If AGP support is implemented in a mobile PC system, it must meet the PC 2001 requirements defined in requirement 14.51, "AGP meets PC 2001 implementation guidelines," with the~~se~~ exception that a minimum speed of 1x is acceptable for mobile PCs.

~~? GART support is recommended, rather than required.~~

If GART support is implemented on a Mobile PC system, it must comply with the requirements specified in *AGP Interface Specification, Revision 1.0* or later.

Notice that an AGP implementation using a memory-mapped frame buffer (frame AGP) rather than GART does not support bus mastering.

~~**6.24 system meets Mobile PC 2001 requirements**~~

~~Television output is not required for a mobile system. If this capability is implemented, the mobile system must support the requirements defined in this chapter with the following exceptions:~~

~~? The television output adapter must use 2-tap minimum hardware filtering techniques for flicker reduction. All other requirements are as defined in item 14.38, "Adapter supports flicker filter."~~

~~? It is acceptable for television output to be enabled manually. Mobile PCs are not required to support automatic default boot mode as defined in requirement 14.36, "Default boot mode supports appropriate locale."~~

6.25 Built-in mobile display supports ICC color management

This capability is required for mobile flat-panel displays, as defined in requirement 16.2, "Monitor supports Integrated Color Management."

The OEM must preinstall an INF and International Color Consortium (ICC) profile for the LCD display if it cannot be detected using DDC or other standard mechanisms. For model variations that use more than one type of panel, the end-user will have to select the correct panel during Setup if the panel is not DDC compliant. For information, see the color management information available from the web site at http://www.microsoft.com/hwdev/devdes/icm.htm.

[14.49] BIOS setup utility on Mobile PC provides option to force use of system-board graphics

The OEM must provide an option in the system BIOS setup utility to force the system-board graphics device to be used, ignoring and disabling any PCI graphics adapters. This option would ensure that a user with a PCI hot-docking system is always able to undock because the VGA device will be in the mobile unit.

Low-Cost Mobile PC Graphics Guidelines

Note to Reviewers: This section will address low-cost mobile systems in a future draft

Low-cost mobile systems must support at least a screen resolution of 640x480 at 8 bpp.

When low-cost systems do support non-required features, then they are required to meet all applicable PC2001 inter-operability standards implied by that feature.

Checklist for Graphics Adapters and Video

[New.1] Desktop system meets basic PC 2001 graphics requirements

14.1 Primary graphics adapter uses AGP 2X or another high-speed connection

14.2 Desktop system provides hardware-accelerated 3-D graphics

14.3 System uses WC with higher-performance processors

[New.2] If implemented, digital monitor interface complies with Digital Visual Interface standard

14.4 Primary graphics adapter works normally with default VGA mode driver

14.5 Adapter and driver support multiple adapters and multiple monitors

14.6 [DELETE] Adapter supports television output if system does not include large-screen monitor

14.7 [Redundant] Adapter meets PC 2001 general device requirements

14.8 Desktop screen resolution and local memory capacity meet PC 2001 minimum requirements

14.9 Adapter meets industry specifications for External Display Interface(s)

14.10 All supported color depths are enumerated

14.11 Graphics operations use relocatable registers only

14.12 Adapter supports adjustable gamma correction

14.13 Adapter for external display supports Plug and Play monitor detection

14.14 [moved] Hardware supports video overlay surface with scaling

14.15 [moved] Hardware supports VGA destination color keying for video rectangle

14.16 [moved] Hardware supports alpha blending of graphics and video

14.17 [moved] Video port meets specifications if present on graphics adapter

14.18 [DELETE] Hardware supports MPEG-2 motion compensation acceleration

14.19 [DELETE] Hardware supports scanning at the same frequency as the incoming video

14.20 Extended resources can be dynamically relocated after system boot

14.21 VGA resources can be disabled by software

14.22 Frame buffer can be accessed directly by applications

14.23 Adapter and driver support linear-mapped, low-resolution modes

14.24 Hardware supports transparent blter

14.25 Hardware provides support to prevent tearing

14.26 Hardware supports programmable blter stride

14.27 Hardware for desktop system supports RGB rasterization

14.28 Hardware for desktop system supports RGB rasterization features

14.29 Hardware supports multi-texturing

14.30 Hardware supports texture formats

14.31 Hardware complies with texture size limitations

14.32 [DELETED]

14.33 Hardware for desktop system supports Z comparison modes and Direct3D-compatible formats

14.34 Hardware for desktop system meets PC 2001 3-D accelerator performance requirements

14.35 [DELETE]

14.36 [DELETED]

14.37 If TV Out is implemented, adapter supports underscan scaling

14.38 If TV Out is implemented, adapter supports flicker filter

14.39 [DELETE]

14.40 If TV Out is implemented, adapter supports composite video connectors

14.41 If TV Out is implemented, adapter with television output supports DVI or VGA and television output

14.42 If TV Out is implemented, software supports positioning

14.43 If TV Out is implemented, software supports detection of television connection

14.44 If TV Out is implemented, analog video outputs support copy protection

14.45 Display devices do not use VGA BIOS POST to populate PCI SVID

14.46 System supports conflict resolution, VGA compatibility, and extended registers

14.47 Chips support linear packed-pixel frame buffer, relocatable above 16 MB

14.48 Option ROM supports DDC2B

[MOVED]

14.50 BIOS supports large frame buffers for graphics adapters

14.51 AGP meets PC 2001 implementation guidelines

14.52 Graphics device supports IRQ and correctly populates PCI BARs

14.53 System-board graphics device is not hidden from Plug and Play enumeration

14.54 Graphics adapter complies with device class power management reference specification

14.55 Graphics adapter complies with VBE/Core 2.0 extensions for power management

14.56 [Redundant] Device drivers and installation meet PC 2001 requirements

14.57 Driver does not bypass any Microsoft-provided system components

14.58 Applications provided with device meet requirements for Win32-based applications

14.59 Driver supports dynamic color depth and resolution change

[NEW.3] Frame buffer implemented using dynamic allocation of system memory

[NEW.4] System supports basic video capabilities

15.17 Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

15.48 All video implementations use DirectShow for video routing and processing

15.49 [REDUNDANT] Each hardware device has a Plug and Play device ID

15.50 [REDUNDANT] Dynamic resource configuration is supported for all devices

15.51 Dependent video device is not independently enumerated

[New.5] If DirectShow filters replace any filters included with the operating system, replacements provide a functional and qualitative superset of the replaced modules

[New.6] All video input devices use WDM drivers

[New.7] All video implementations meet basic video quality requirements

15.10 System supports DV decoding and encoding

15.14 All MPEG-2 decoders can accept an MPEG-2 elementary stream

15.15 All MPEG transport stream information is available to the central host processor

15.16 [DELETE] Background tasks do not interfere with MPEG-2 playback

15.17. [MOVED] Video input, capture, and broadcast device support is based on DirectX foundation class and WDM Stream class

15.18 [DELETE] All components meet PC 99 general device requirements

15.19 [DELETE] MPEG-2 MP@ML playback meets PC 99 requirements

15.20 [DELETE] MPEG-2 playback for ATSC, DVB, or other digital TV systems meets requirements

15.21 [DELETE] MPEG-2 video decode implementations meet quality requirements

15.22 [DELETE] De-interlacing of standard-definition video meets requirements

15.23 If implemented, MPEG-2 decoder supports the pull-down algorithm

15.24 If DVD-Video playback is implemented, DVD decoder driver correctly handles media types, time discontinuity, and decode-rate adjustment

15.25 If DVD-Video playback is implemented, DVD decoder supports subpicture compositing and closed captioning

15.26 If DVD-Video playback is implemented, subpicture decoder correctly handles subpicture properties and other functions

15.27 If DVD-Video playback is implemented, system supports seamless DVD-Video 1.0 navigation

[NEW.8] DVD-Video player provides seamless and gapless DVD navigation

15.28 All DVD video decoders must support Line21 closed-caption data

15.29 [DELETE] System provides a licensed CSS copyright protection scheme

15.30 [DELETE] Analog video decoder such as NTSC/PAL/SECAM meets quality requirements

15.31 If implemented, analog video capture device outputs video data at 3.7 MB/sec, minimum

15.32 If implemented, video input or capture device provides raw sampled VBI data to the host

15.33 [DELETE] Digital video camera uses external bus support

15.34 [DELETE] Video input image orientation identification meets requirements

15.35 [DELETE] Analog TV tuner/decoder supports PC 99 audio and video performance

15.36 [DELETE] Analog TV tuner/decoder includes stereo audio decoder and supports SAP

15.37 If implemented, VBI capture oversamples VBI data at least four times

15.38 [DELETE]

15.39 If implemented, digital broadcast module can receive all streams contained in the particular transport stream

15.40 If implemented, digital broadcast module can receive full bandwidth from each frequency

15.41 If implemented, digital broadcast module can receive a minimum of 32 simultaneous elementary streams

15.42 [DELETE]

15.43 If implemented, digital broadcast module provides support for conditional access

15.44 [DELETE]

15.45 [DELETE]

15.46 [DELETE] g

15.47 If implemented, ATSC DTV tuner/demodulator is fully implemented

15.48 [DELETE]

[New.9] Tethered video devices must support video modes of at least CIF at 15 fps or better

[New.10] Tethered video devices must support the YV12 and IYUV FOURccs and formats

[New.11] USB camera does not utiltize more than 5 Mb/s USB bandwidth at 15 fps CIF

14.14 If support for TV or DVD video playback is implemented, hardware supports video overlay surface with scaling

[New.11] If support for TV or DVD video playback is implemented, overlay supports YUY2 and YUV12 color space conversion to RGB

[New.12] If support for TV or DVD video playback is implemented, colorspace conversion can be configured for different color primary standards

14.15 Hardware supports VGA destination color keying for video rectangle

14.16 If support for TV or DVD video playback is implemented, hardware supports alpha blending of graphics and video

14.17 Video port meets PC 2001 specifications if present on graphics adapter

6.20 Mobile system meets Mobile PC 2001 requirements for supporting multiple adapters and multiple monitors

6.21 Mobile system's external graphics adapter interface supports DDC monitor detection

6.22 If MPEG-2 or DVD playback features are implemented, mobile system meets Mobile PC 2001 requirements

6.23 If AGP is implemented, system meet Mobile PC 2001 requirements

6.25 Built-in mobile display supports ICC color management

[14.49] BIOS setup utility on Mobile PC provides option to force use of system-board graphics